U.S. EPA REMOVAL ACTION
NH DIOXANE CONTAMINATION SITE, ATKINSON, NEW HAMPSHIRE

EVALUATION OF MITIGATION OPTIONS
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Region 1 Superfund Technical Assessment and Response Team III
Contract EP-W-05-042, Task Order 0008

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U.S. Environmental Protection Agency (EPA) has requested that Weston Solutions, Inc. (WESTON®) under the Region 1 Superfund Technical Assessment and Response Team III (START) contract provide technical assistance in the form of engineering design products and services for the New Hampshire Dioxane Contamination Site (SSID: 01KA, the Site), located in Atkinson, Rockingham County, New Hampshire. The work was authorized as a Task Order (TO) in accordance with START Contract Line Item Number (CLIN) 1002 Non-Level A services using the Indefinite Delivery/Indefinite Quantity (ID/IQ) fixed labor categories, CLIN 1005 (Travel) and CLIN 1006 [Other Direct Costs (ODCs)] in response to the EPA Statement of Work (SOW), entitled *Statement of Work, New Hampshire Dioxane Contamination, SSID 01KA, Atkinson, New Hampshire, Task Order for Technical Assistance, Originally issued May 9, 2012; Revised on June 6, 2012.*

Prior effort under this Scope of Work included providing technical assistance to EPA with a preliminary review of documents, a site visit by representatives of the WESTON ID/IQ primary project team and discussions with the EPA On-Scene Coordinator (OSC). The WESTON ID/IQ project team reviewed project understandings and relevant data obtained as part of the TO and identified to the OSC in a memorandum deficiencies in data potentially critical for further engineering work and/or implementation of likely mitigation approaches at the Site. Effort to obtain the necessary data is underway by the OSC with support from the START Core Readiness Team (CRT) and others.

Another element of the Scope of Work is to identify and evaluate at least three alternative approaches to provide drinking water to residents in the Area of Concern and present this evaluation in a brief memorandum to the OSC. The memorandum is to provide a listing of the identified options, along with brief descriptions, potential advantages and disadvantages, long-term operation and maintenance (O&M) requirements, estimates of comparative costs for both initial implementation (including cost per linear foot) and long-term O&M. EPA will use the information presented in the memorandum to weigh the options and select an approach for further action.

The following presents the results of WESTON's evaluation of options.

SITE UNDERSTANDING

The New Hampshire Department of Environmental Services (NHDES) requested assistance from EPA to address 1,4-Dioxane contamination in private drinking water wells located in the vicinity of Emery Drive, Belknap Drive, Brookside Terrace, Oak Ridge Drive, Deer Run Road, and Stonewall Terrace in Atkinson, New Hampshire. The concentration of 1,4-Dioxane was found to

exceed the NHDES Ambient Groundwater Quality Standards (AGQS) of 3.0 micrograms per liter (µ/L) in several wells. NHDES is investigating but has not yet been able to identify the source of the 1,4-Dioxane groundwater contamination. Investigations as to the source and extent of the impact are ongoing. Subsequently, additional investigation identified potential impact to private water supplies at the Waterwheel Estates development on Chandler Drive which is currently served by a small community water supply, and some homes on West Side Drive south of Oak Ridge Drive. These various areas represent the Area of Concern for EPA's action.

NHDES became aware of the private drinking water well contamination when routine well testing indicated the presence of 1,1-Dichloroethane and 1,2-Dichloroethylene. NHDES initiated a sampling effort to determine the extent of groundwater contamination in the area and the possible source. During the investigation, NHDES discovered the presence of 1,4-Dioxane, a contaminant that is not normally analyzed for during the routine well sampling.

As presented by the EPA OSC, EPA plans to perform a Removal Action at the Site to mitigate the imminent hazard of contaminants present in the private residential drinking water wells in the area. While NHDES will continue the investigation regarding the source and extent of the contamination, EPA's work will focus on providing a safe source of drinking water to the impacted homes in the Area of Concern. Work will include evaluating various options for the supply of drinking water, the EPA selection of the option, and the design and implementation of that alternative. A large community water supply owned and operated by the Hampstead Area Water Company (HAWC) currently serves many areas of Atkinson but none of the impacted homes are currently served by HAWC (most of the impacted homes are not within the current HAWC service area), and connection to this supply will be evaluated.

Several potential approaches have been identified for the Site that will address the issues of concern for EPA. These approaches include:

- Furnishing bottled water (current short-term approach and baseline option).
- In-home individual water treatment units (Point of Entry Units).
- Connection to the HAWC water source and distribution system.
- Connection to the nearest publicly owned water system.
- Development of new water source(s), potential treatment, and distribution.

These approaches form the basis of WESTON's evaluation.

EVALUATION OF ALTERNATIVES

Basis for Evaluation

The objective of the EPA Removal Action is to cost-effectively mitigate the hazard to local residents of the presence of 1,4-Dioxane in the private drinking water wells. The primary route of concern is through ingestion; therefore, the focus is on water used for drinking and cooking. Secondary concerns include incidental ingestion of water through hygiene (toothbrushing, showers, etc.) and dishwashing. Off-gas inhalation or skin contact with the impacted groundwater is not a focus.

The investigation into the source and extent of the contamination continues so the exact identification of impacted wells is still being determined. As a basis for this evaluation and

comparison of options, 34 residences are considered impacted by 1,4-Dioxane (samples showing levels above the detection limit of 0.30 µ/L) and 130 additional residences (including 34 units at Wagonwheel Estates condominiums) are considered to have the potential for impact based on proximity to impacted wells and feasibility to be included in some of the mitigation options.

To be suitable, an approach must reliably provide clean water to the residents in a cost-effective manner. It must be able to be to be implemented in a time-critical fashion and it must be a long-lasting solution. In addition, because of EPA Removal Program constraints, EPA's direct involvement must be relatively short-term in nature, and implemented so that another agency or party manages any long-term activities/support.

Following is a discussion of the each of the evaluated alternatives, including methods of delivery, practical range of uses by a residence, advantages and disadvantages, and specific issues for implementation. The alternatives that were evaluated vary in their ratio of capital to long-term operational costs. To help make all of the alternatives comparable, a present value analysis was used to capture estimated costs expected to be incurred over a period of 20 years with an inflation factor of 3%.

Continuation of Bottled Water Service

Currently, the emergency, short-term means to supply clean water to residents has been through the supply of bottled water to the impacted homes. This method has been implemented by the NHDES and is functional. For the purpose of this evaluation, the continued supply of bottled water is considered the baseline alternative. This option entails installation of a dispenser in each home with ongoing delivery of water via 5-gallon bottles. Commercial vendors perform this service, including furnishing the dispenser and maintaining a stock of water at each home. The service would be a continuing expense for the EPA or responsible agency.

This option provides the minimal quantity of water to address the primary route of concern – ingestion via drinking or cooking. Supply of bottled or "containerized" water is not practical for other in-home uses like bathing, laundry or other piped domestic uses. Water for exterior use is not provided.

Cost Estimate Factors:

- Average household usage for drinking and cooking is 1 gallon per day (gpd).
- Current cost per 5-gallon bottle of water via delivery contract is $6.19.
- Dispenser rental is included in per bottle cost.
- Capital Costs: $20/home, $680 for 34 homes
- Yearly O&M Costs: $450/home, $15,300 for 34 homes
- Present value of costs: $13,000/home, $442,000 for 34 homes

Advantages:

- Second lowest cost option.
- No engineering or construction required.
- Costs targeted to the specific need.

- Expandable to as many homes as needed with incremental cost.

Disadvantages

- Provides water only for cooking and drinking.
- Requires residents to consciously select bottled water for each use (not automatic).
- Inconvenience to residents (placement of dispenser, changing bottles, delivery).
- Costs to EPA or responsible agency continue forever.
- EPA or responsible agency must administer program (oversight, QC, contract renewal; administrative costs are not included in estimates).

In-Home Individual Water Treatment Units (Point of Entry Units)

Treatment of drinking water wells contaminated with 1,4-Dioxane on a per-home basis is a potential option subject to certain limitations. In-home individual treatment units, also known as point of entry treatment units, can be used to treat residential well water for a variety of contaminants. However, the characteristics of 1,4-Dioxane can limit the practicality of in-home treatment. Current research indicates that granular activated carbon (GAC) can be effective to treat moderate 1,4-Dioxane contamination levels (15 µ/L) to levels below the current AGQS of 3.0 µ/L. GAC units can be practically used in an in-home application and could utilize standard off-the-shelf components. The process used for in-home treatment units would need to be pilot tested for this locality to ensure success given the particular concentrations of 1,4-Dioxane and other potentially process-inhibiting compounds that may be present in the groundwater.

However, higher levels of contamination or a lower target limit such as the risk-based level of 0.35 µ/L (currently not the regulatory standard) would require treatment processes such as ultraviolet or ozone, in addition to GAC. These processes would increase the cost and operational complexity such that it would be impractical for in-home use.

If the particular criteria at the site allows for use of GAC units for in-home treatment, the units would need to be sized depending on the range of uses that would receive the treated water. For example, a small GAC unit can be plumbed to serve the kitchen sink through a supplemental tap. This would make the treated water available for use in cooking and drinking without the inconvenience of bottled water. The GAC canisters could be changed by the homeowner on a regular schedule to avoid breakthrough or fouling. Larger units could be installed such as in the basement and plumbed to supply treated water to all of the interior plumbing. This would provide treated water for uses such as bathing and laundry but at a higher capital and operational cost including annual bulk change-out of carbon from 100 or 200 pound vessels. In theory, units could be used to supply all water uses including exterior uses such as irrigation, garden hoses and pools, but size and cost become prohibitive.

Cost Estimate Factors:

- Average household usage for drinking and cooking is 1 gpd.
- Average household usage for all indoor uses is 250 gpd.
- Assumed influent concentration of 15 µ/L and treatment criteria of 3.0 µ/L.
- Assumed spent carbon would not be hazardous waste.

- Capital Costs: $3,200/home, $109,000 for 34 homes.
- Yearly O&M Costs (drinking/cooking water only) $200/home, $6,800 for 34 homes.
- Yearly O&M Costs (household interior uses) $1,100/home, $37,400 for 34 homes.
- Present value of costs (drinking/cooking only): $9,000/home, $306,000 for 34 homes.
- Present value of costs (household interior uses): $33,400/home, $1,136,000 for 34 homes.

Advantages

- Requires little construction.
- Lowest cost option for providing only drinking/cooking water.
- Limited homeowner inconvenience.
- Can be sized to handle broader range of water uses.
- Expandable to as many homes as needed with incremental cost.

Disadvantages

- Requires pilot testing to confirm applicability (not included in estimates).
- Does not practically provide treated water for exterior uses.
- Not practical for higher influent concentrations or to meet a standard below 3.0 µ/L – need to monitor concentrations influent/treated water for changes.
- Requires residents to change carbon media at least once per year.
- Inconvenient to residents (possible separate tap, changing carbon media).
- Costs to EPA or responsible agency continue forever.
- EPA or responsible agency must administer program (oversight, monitor influent and treatment effectiveness, QC, contract renewal; administrative costs are not included in estimates).

Connection to the HAWC Water System and Extension of the Distribution System

An alternative to the supply of bottled water or individual in-home treatment of existing residential wells is to supply water to impacted homes from a central, non-contaminated source via a distribution system. The distribution system is a network of underground pipes, pressurized with water, and connected to individual homes as a utility. There are many possible configurations for a distribution network and several approaches for a source of water. This alternative focuses on using the nearby HAWC water system as a source and uses a typical municipal water distribution system approach which is consistent with HAWC's standard practice. The existing HAWC distribution system is in close proximity to the Area of Concern so this alternative is essentially an extension of the existing system.

For this evaluation, the envisioned system includes all of the components of a typical municipal water system except for capability for high demand fire protection flows (more than 500 gpm). Having been developed as a conglomeration of numerous community water systems serving individual subdivisions, the HAWC system is fed from numerous source wells located throughout its system. According to HAWC officials, the existing system has the capacity for

approximately 100 additional homes in its current configuration. Fire protection service is of limited availability in the existing HAWC network, so limited fire protection capability in the extension is consistent.

Based on similar projects performed by EPA in the past, it is envisioned that the distribution system would be constructed to serve the impacted homes in the Area of Concern including completing service connections to the impacted homes and, once operational, the distributions system would be relinquished to the existing water utility entity for operation and maintenance. Connected homes would then be customers of HAWC and would pay users fees to HAWC for the water and the services. The distribution system would be constructed to the typical standards of the water utility (HAWC) and, following good engineering practice, would be designed to be capable of serving all of the homes in the area, whether or not they are actually connected as part of the EPA action. This is a result of impacted homes being interspersed between non-impacted homes; non-impacted homes may be connected to the system as part of the project or in the future.

It is difficult to directly compare this alternative to the bottled water or in-home treatment options because of the significant differences in scope. The bottled water and in-home treatment alternatives are limited in scope and target the mitigation effort to only the specific homes and specific water uses that are the highest priority. In contrast, the construction of a water distribution system is a capital intensive approach, but it establishes the permanent infrastructure needed to supply the targeted homes. Contrary to the bottled water and in-home treatment options, the distribution system option ties into each home's existing plumbing and can provide non-contaminated water for all household uses, not only for drinking and cooking. In addition, servicing additional homes that are on the route of the distribution system is a relatively small incremental cost compared to the base cost. Cost estimates for the distribution system option include connections to the 34 currently impacted homes, as well as estimates for connection of all 164 homes for the fully comprehensive scope.

For the purposes of developing a cost estimate for comparison of options, this alternative includes an 8-inch (in) diameter polyvinyl chloride (PVC) pipe water main from a connection to the existing HAWC system at the intersection of Island Pond Road and Main Street (Route 121), and along West Side Drive, Emery Drive, Belknap Drive, Brookside Terrace, and Stonewall Terrace, Oak Ridge Drive and Deer Run Road. Mains along Oak Ridge Drive and Deer Run Road will be 6-inch PVC pipe with connection to an existing HAWC 6-in main at West Side Drive. Also included is a connection to Waterwheel Estates condominiums through an easement to Belknap Drive and a possible easement from Oak Ridge Drive to Emery Drive.

Cost Estimate Factors:

- Estimated unit costs are developed from NH public construction bid prices from 2011 and 2012.
- Estimate for 8-in water main is $120 per linear foot (LF), 6-in is $100/LF.
- Linear foot cost includes pipe installed, tested, and disinfected, trenching and backfill, restoration.
- Fittings, tees, hydrants, and ledge excavation are estimated separately (not in unit cost per LF).

- Curb stops/corporations, service piping, and plumbing connections are estimated separately.
- Mobilization, bonds, traffic control, erosion control, special work are included in LF cost.
- Estimated main lengths are 18,000 LF of 8-in, 3,500 LF of 6-in.
- Allowance for ledge excavation is 200 cubic yards (CY) at $200/CY, subject to survey.
- Estimated Average Cost per Home Connection is $10,000.
- Capital Costs: $3,000,000 for 34 homes connected, $4,300,000 for 164 homes.
- Yearly O&M Costs considered $0 because user fees compensate for O&M.
- Present value of costs: $3,000,000 for 34 homes connected, $4,300,000 for 164 homes.

Advantages

- Completely eliminates use of impacted wells for any water to the home.
- Provides for all uses (drinking, cooking, dishwashing, bathing, laundry, exterior).
- Permanent system in place with water supply managed by responsible entity.
- Additional homes in the Area of Concern may be connected if needed or by choice, now or in future.
- EPA may disengage from the project upon system turnover to HAWC – no trailing costs.
- Operation and maintenance of water system is handled by experienced professionals.
- Ongoing maintenance cost is low and is paid by user fees.
- Residents no longer must operate and maintain own private wells.
- Water quality is monitored by HAWC per NHDES requirements as part of system operations.

Disadvantages

- Significant capital cost.
- Requires engineering, land survey, potential land acquisition/easements (not included in estimates).
- Neighborhoods disrupted by construction for 4 to 6 months.
- Connected residents must pay user fees to HAWC.
- Requires HAWC to use its remaining surplus supply capacity.
- Requires Public Utilities Commission approval of expanded service area for HAWC.

Development of New Water Source(s), Potential Treatment and Distribution

Under this alternative, a new community water supply would be developed to serve the impacted homes and possibly other homes in the Service Area. The new source could be a surface water source but more likely would be a new groundwater supply well. The water from the new source would need to be piped to the impacted homes via a distribution system, similar to that for the HAWC system extension described above.

The development of an independent source allows this mitigation option to remain independent of HAWC, a for-profit water utility. However, an entity would need to operate and maintain the new source and distribution system. This entity could be a municipal agency such as a department of the Town of Atkinson, a village precinct or community association. The entity would need to become designated as an approved water supplier and would operate and maintain or contract the O&M of the system. Connected residences would become users of the system and would pay a fee for the water and service.

Development of a new source in the area poses some challenges. The source must not be impacted by the 1,4-Dioxane contamination, nor any other source of contamination. The source must be relatively close to the service area or the water must be piped to the service area. Wells (at least two for redundancy) must yield sufficient water to safely supply the demand, even under dry conditions. Undeveloped land for the wells and the required protective radii must be identified and acquired. Potentially, an NHDES Large Groundwater Withdrawal Permit (required for wells over 57,600 gpd) would be necessary including application and public hearing.

For the purposes of developing a cost estimate for comparison of options, this alternative is assumed to include a distribution system identical to that included in the HAWC system extension above. In addition to the distribution system, the cost to identify, develop, and permit a pair of supply wells with treatment is estimated. The quantity of homes serviced may be limited by the safe yield of the source such that non-impacted homes may not have the option to connect to the system.

Cost Estimate Factors:

- Distribution system costs are the same as for the HAWC system extension plus the cost for developing a new source.
- Estimate for study, test wells, well design and permitting is $170,000.
- Estimate for well installation, pumps, tanks, utilities, house, access, etc. based on range of flow is $200,000-230,000.
- Estimate for a water treatment system based on flow ranges is $30,000-60,000.
- Safe yield may limit the number of connected homes.
- Capital Costs: $3,400,000 for 34 homes connected, $4,800,000 for 164 homes.
- Yearly O&M Costs considered $0 because user fees compensate for O&M.
- Present value of costs: $3,400,000 for 34 homes connected, $4,800,000 for 164 homes.

Advantages

- Completely eliminates use of impacted wells for any water to the home.
- System provides for all uses (drinking, cooking, dishwashing, bathing, laundry, exterior).
- Permanent system in place with water supply managed by responsible entity.
- Potentially additional homes in the Area of Concern may be connected if needed or by choice.
- EPA may disengage from the project upon system turnover to operator – no trailing costs.

- Operation and maintenance of water system is handled by system operator.
- Ongoing maintenance cost is paid by user fees.
- Residents no longer must operate and maintain own private wells.
- Water quality is monitored by the system operator per NHDES requirements as part of system operations.

Disadvantages

- Significant capital cost.
- Requires engineering, land survey, land acquisition easements (not included in estimates).
- Requires an entity to operate the system as a community system.
- Requires hydrogeologic investigation, testing and permitting of wells.
- Neighborhoods disrupted by construction for 4 to 6 months.
- Connected residents must pay user fees to operator.
- User fees would be based on distributing the costs for O&M across the user base – fewer users would be responsible for the fixed costs.
- Investigation and permitting of a new well take more than 6 months after suitable location is found and available.
- Local source may become contaminated by the 1,4-Dioxane plume.
- Significant uncertainty of feasibility of this option without further investigation into potential sources.

Extension of Water System from the Nearest Publicly Owned System

Under this alternative, the nearest publicly owned water utility would be sought as a source to serve the impacted homes and possibly other homes in the Service Area. The water from the new source would need to be piped to the impacted homes via a distribution system, similar to that described for the HAWC system extension described above.

The development of a publicly owned source allows this mitigation option to remain independent of HAWC, a for-profit water utility. However, an entity would need to operate and maintain the connection to the utility and the neighborhood distribution system because it is unlikely that the publically owned utility would be able to extend its responsibility to Atkinson. Similar to the new source option described above, this new entity could be a municipal agency such as a department of the Town of Atkinson, a village precinct or community association. The entity would need to become designated as an approved water supplier and would operate and maintain or contract the O&M of the system. Connected residences would become users of the system and would pay a fee for the water and service. The entity, in turn would buy the water from the publicly owned water utility.

For the purposes of developing a cost estimate for comparison of options, this alternative is assumed to include a distribution system identical to that included in the HAWC system

extension above. In addition to the distribution system, the cost is estimated to construct the transmission main for connection to the publicly owned system.

Cost Estimate Factors:

- Distribution system costs are the same as for the HAWC system extension plus the cost for the transmission main.
- Additional pumping, treatment and storage may be necessary for connection but the cost is not estimated.
- Assumed distance to nearest publicly owned system is 5 miles to the Town of Salem system.
- Capital Costs: $6,200,000 for 34 homes connected, $7,500,000 for 164 homes.
- Yearly O&M Costs considered $0 because user fees compensate for O&M.
- Present value of costs: $6,200,000 for 34 homes connected, $7,500,000 for 164 homes.

Advantages

- Completely eliminate use of impacted wells for any water to the home.
- Provides for all uses (drinking, cooking, dishwashing, bathing, laundry, exterior).
- Permanent system in place with water supply managed by responsible entity.
- Water supply maintained by neighboring publicly owned water system.
- Additional homes in the Area of Concern may be connected if needed or by choice, now or in future.
- EPA may disengage from the project upon system turnover to operator – no trailing costs.
- Operation and maintenance of water system is handled by system operator.
- Ongoing maintenance cost is paid by user fees.
- Residents no longer must operate and maintain own private wells.
- Water quality is monitored by the system operator per NHDES requirements as part of system operations.

Disadvantages

- Highest capital cost.
- Requires engineering, land survey and potential easements for long transmission main easements (not included in estimates).
- Requires an entity to operate the system as a community system.
- Need for additional pumping, treatment and storage may be necessary for connection (not included in estimates).
- Neighborhoods disrupted by construction for 4 to 6 months.
- Connected residents must pay user fees to operator.

- User fees would be based on distributing the costs for O&M across the user base – fewer users would be responsible for the fixed costs.
- Permitting and construction of long transmission main may delay implementation.
- No interest by nearby publicly owned system yet identified.
- Requires intermunicipal agreement for water supply and supplying utility must use excess or develop additional capacity to supply (administration and capacity increases are not included in the estimate).
- Significant uncertainty of feasibility of this option without further investigation into potential water supply entities.

RECOMMENDED ACTIONS

Based on the evaluation of options presented above, the least cost option on a present worth basis is the in-home individual water treatment units, followed closely by the continued supply of bottled water to the impacted homes for drinking and cooking water uses. However, the in-home treatment units have a narrow range of application and require pilot testing to confirm their effectiveness. Factoring in the pilot testing and uncertainty, the cost between in-home treatment and bottled water would be similar. Regardless, both of these options will require ongoing funding for maintaining the water service and administration of the program to ensure vendors meet the needs of the program. Plus, bottled water service is an inconvenience for residents and is usually considered a temporary measure, used only until a permanent measure is in place.

WESTON recommends pursuit of the alternative that would entail connection to the HAWC water system via an extended distributions system to the neighborhoods of impacted homes. While the estimated capital cost of such a system is significant, implementation would bring a permanent solution to the Area of Concern including supply from an established, permitted water utility with multiple, distributed water sources. At a minimum, impacted homes would be connected initially, and other homes in the service area may be connected initially or in the future. At connected homes, water would be fed into the home plumbing in place of the private well supply, such that all water uses throughout the home would receive utility supplied water. Interior plumbing modifications may be made to allow the existing private wells to be retained in service to supply exterior uses such as irrigation as a cost savings to the residents and to reduce the demand on the utility.

With authorization, work may begin right away to perform the preliminary engineering necessary to further define the conceptual distribution system and to secure assurances from the HAWC of its ability to supply water of sufficient volume, rate and quality to serve the Area of Concern.

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